Effects of Grass Carp on Warmwater Fish and Coho Salmon in Devils Lake, Oregon

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Introduction

Devils Lake is a 678 acre natural lake on the north-central Oregon Coast. It has a drainage area of 24 square miles and an average depth of 10 feet (maximum depth 22 feet). The lake is highly eutrophic and is situated in a maritime climate immediately adjacent to the ocean.

Fish resources within the lake and the associated drainage basin include native populations of coho salmon, cutthroat and steelhead trout. In addition, warmwater gamefish including largemouth bass, bluegill, black crappie, yellow perch and brown bullhead have been present since their introduction early in the century. Warmwater gamefish were eradicated from the lake in 1959 when the lake was treated with rotenone to remove European Carp. The treatment resulted in elimination of European carp, but warmwater gamefish that were present before treatment were soon re-introduced. The lake has been stocked with catchable size rainbow trout for many years and currently receives 24,000 rainbow trout each spring at a size of 3 fish per pound.

Sterile triploid grass carp were introduced into the lake in 1986 (10,000 stocked) and 1987 (17,000 stocked) as part of a program initiated by area residents to restore water-based recreation. Recreational use of the lake had been severely curtailed by an invasion of exotic aquatic macrophytes that covered most of the lake's surface area.

Effects of grass carp during the six years following initial introduction in 1986 were evaluated in two studies (Thomas et. al., 1989 and CH2M Hill, 1994.). These studies looked at response of aquatic vegetation, water quality and fish assemblages to the grass carp introduction. They determined that:

1. Aquatic macrophytes remained abundant during this time frame.
2. Water quality was variable with no clear effect from grass carp.
3. Fish populations were variable with no clear effect from grass carp.

In response to the still abundant aquatic macrophytes, an additional 5,000 grass carp were stocked in 1993. By 1994, essentially all aquatic macrophytes disappeared from the lake (Systma, 1996) and have not re-established as yet.

This report summarizes and discusses recent trends in the fish resources of Devils Lake since grass carp introduction, with emphasis on the years following macrophyte elimination. Information on Devils Lake fish resources during recent years has been collected primarily by ODFW and includes:

1. Annual electrofishing of the lake during the spring and fall.
2. Gillnet sampling at irregular intervals.
3. Catch information from bass fishing tournaments.
4. Annual adult coho salmon spawner counts in Rock Creek.

Results

Warmwater gamefish have declined sharply since aquatic macrophytes were eliminated from Devils Lake in 1994. This decline appears to have occurred in all introduced warmwater gamefish including largemouth bass, bluegill, yellow perch, black crappie and brown bullhead.

Largemouth bass

The largemouth bass population in Devils Lake is currently characterized by a moderate abundance of large fish in combination with seasonally abundant young of the year bass (Tables 1 and 2, Figures 1 and 2). Fish within the 7 to 14 inch size range are present in very low abundance. Young of the year bass observed in fall electrofishing are essentially gone by the following spring. The mechanism causing the poor over winter survival of small bass is not known. It is hypothesized that in the absence of aquatic macrophytes, the small largemouth bass are vulnerable to heavy predation by avian predators (diving ducks, cormorants, etc.) and larger fish (adult bass, etc.). Bass tournaments at Devils Lake corroborate the interpretation from electrofishing (Table 3, Figure 3). Average fish weight in bass tournaments has steadily increased in Devils Lake and is now the highest in the state. This is presumably due to lack of recruitment of small bass into intermediate size ranges. This absence of recruitment, if it continues, will lead to very low largemouth bass abundance as older fish are harvested or die.

Table 1. Length frequency of largemouth bass electrofished in Devils Lake during annual ODFW Fall sampling.

	YEAR							
Length (inches)	1992	1993	1994	1995	1996	1997	1998	Total
1	1	1					1	3
2	26	44	14	39	29	9	12	173
3	65	106	74	181	141	24	51	542
4	21	24	79	164	126	18	63	495
5	3	20	54	17	126	12	41	273
6	11	5	28		26	1	11	82
7	7	1	9	1		2		20
8	5							5
9				2	1			3
10	4			1	1			6
11	3							3
12	1							1
13						1		1
14	1							1
15								0
16			1					1
17	1		1	2	1	1		6
18	2	2		2				6
19		1	1			1	1	4
20			1	1				2
>20					1			1

Table 2. Length frequency of largemouth bass electrofished in Devils Lake during annual ODFW Spring sampling.

	YEAR						
Length (inches)	1993	1994	1995	1996	1997	1998	Total
1							0
2	1			1		1	3
3		1		2			3
4				1		1	2
5						1	1
6							0
7	1						1
8							0
9							0
10				1			1
11							0
12							0
13		1					1
14		1					1
15	3	3					6
16		2	3				5
17	3	1		1	1	1	7
18	2		1	4	3		10
19	2		1			1	4
20	1	1					2
>20							0

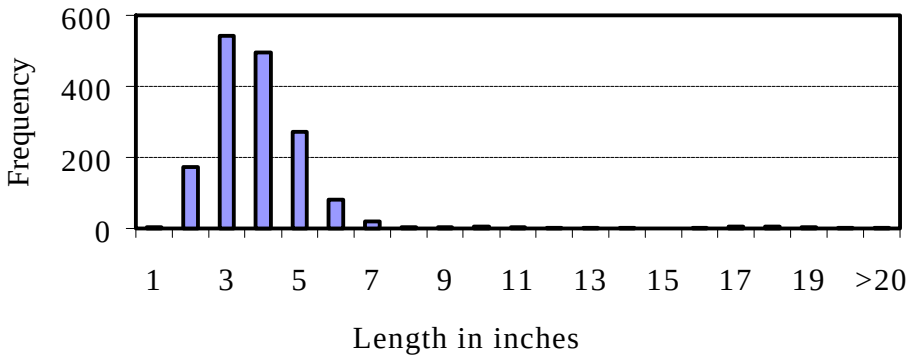

Figure 1. Devils Lake largemouth bass length frequencies for 1992-1998 fall sampling.

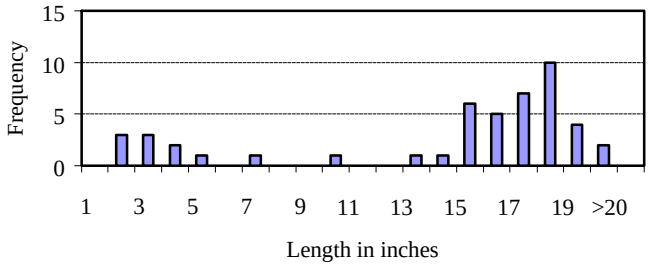

Figure 2. Devils Lake largemouth bass length frequencies for 1993-1998 spring sampling.

Table 3. Devils Lake bass tournament results for 1984-1997.

YEAR	MIN LENGTH	# EVENTS	ANG DAYS	# BASS	BASS PER ANG-HR	AVG WT
1984	12	4	81	101	0.13	2.00
1985	12	5	95	142	0.17	2.10
1986	12	1	8		0.14	1.90
1988	12	1	21	13	0.08	2.37
1989	12	5	56	63	0.12	2.66
1990	12	2	24	23	0.11	2.77
1991	12	2	16	29	0.22	2.93
1992	12	1	11	9	0.10	3.28
1993	12	6	71	69	0.11	3.42
1994	12	5	93	97	0.10	4.19
1995	12	4	41	26	0.06	4.19
1996	12	1	13	9	0.08	4.22
1997	12	1	15	15	0.14	4.67

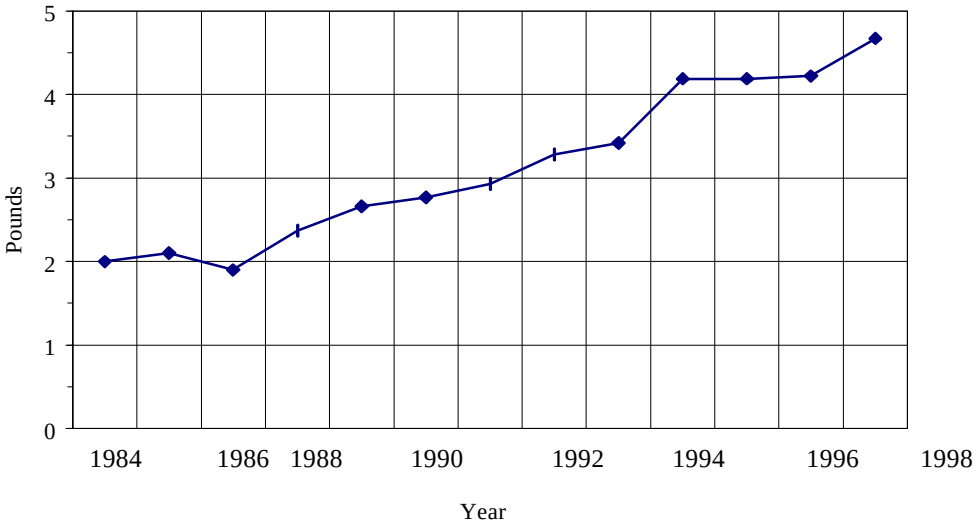

Figure 3. Devils Lake largemouth bass: average weight of tournament fish.

Bluegill, black crappie, yellow perch and brown bullhead

All species of warmwater gamefish commonly referred to as panfish appear to have declined to very low levels since aquatic macrophytes were eliminated from Devils Lake. This decline is evident from annual fall electrofishing and miscellaneous net samples from the lake (Tables 4 and 5, Figures 4 and 5). Anglers fishing Devils Lake for panfish report results consistent with the various inventory data. The mechanism explaining the major decline in Devils Lake panfish is unknown. It is hypothesized that in the absence of macrophytes, panfish are excessively vulnerable to predation.

Table 4. Warmwater gamefish captured in Fall electrofishing at Devils lake, excluding largemouth bass.

	CPUE (Fish per 1000 Sec)		
YEAR	BLUEGILL	PERCH	CRAPPIE
1985	39.8	26.4	3.7
1986	40.7	32.5	19.9
1992	113	19.6	8.8
1993	20.8	136.6	7.5
1994	0	5	0
1995	0.6	9	0
1996	0.7	0	0
1997	1.4	1.4	0
1998	1.4	0	0

Table 5. Gillnet and trapnet results from Devils Lake.

DATE	BLUEGILL	PERCH	CRAPPIE	BULLHEADS
5/81	0	593	35	135
3/84	2	35	5	19
10/92	44	64	55	139
5/93	23	6	2	22
7/94	4	2	0	2
9/94	1	11	0	16
5/9/96	0	0	0	3
10/96	1	5	0	0
4/25/97	0	0	0	0

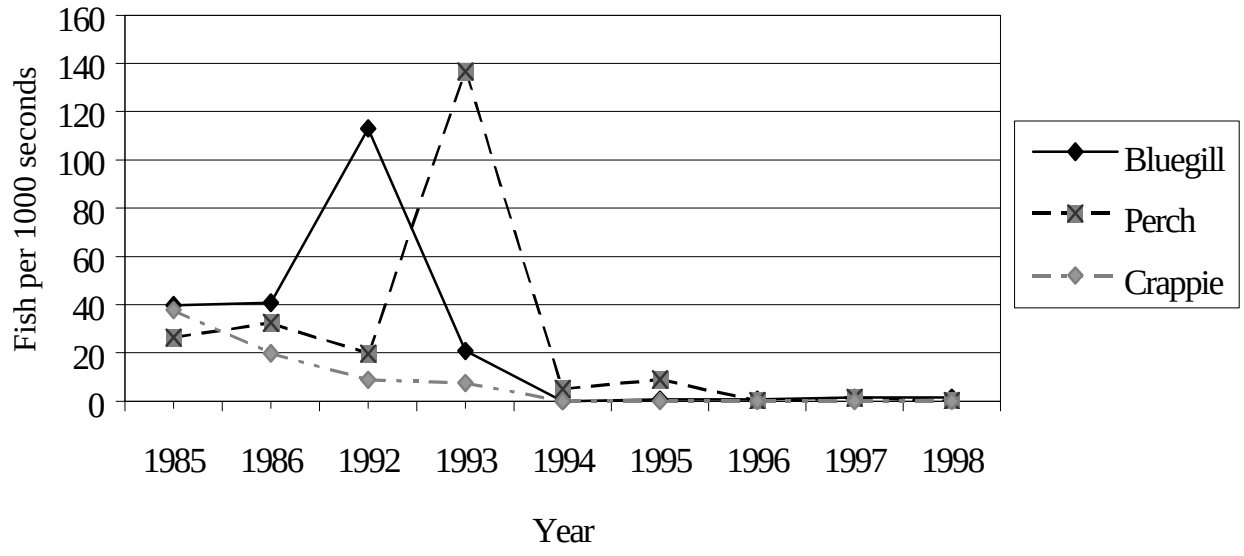

Figure 4. Fall electrofishing samples of panfish from Devils Lake.

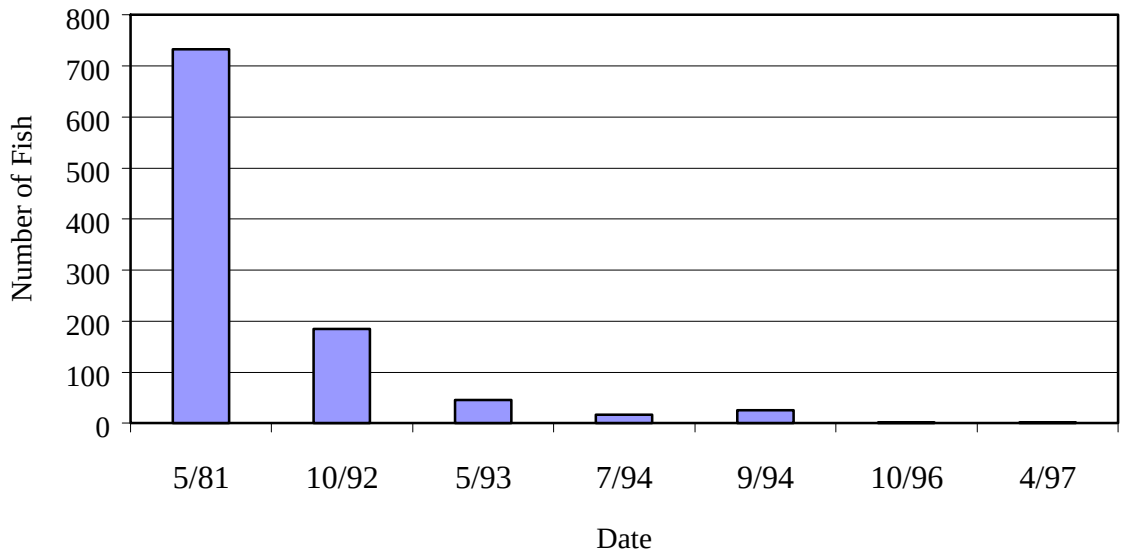

Figure 5. Catchable size panfish caught in net samples from Devils Lake.

Coho salmon

Coho salmon abundance in the Devils Lake Drainage Basin is indexed annually based on spawning fish surveys in Rock Creek, the primary tributary feeding into the lake. Adult coho abundance in these surveys has been highly variable between years with no clear declining or increasing trend evident (Table 6, Figure 6). The adult coho returns in 1996 would be the first age class where the juvenile life history stage was subjected to a macrophyte-free lake. Since 1996, adult coho returns are within the range of previous years. However, during this time frame, coho salmon in other north-central Oregon coast streams have been at record low levels. Factors thought to contribute to the low wild

coho returns in this area are El Niño ocean conditions and severe flooding in February, 1996. It is currently not possible to associate changes in the Devils Lake environment with adult coho returns.

Table 6. Adult coho salmon peak count in the two Rock Creek (Devils Lake) spawning surveys. Both surveys are one mile in length.

YEAR	Lower Survey	Upper Survey
1980	11	
1981	7	
1982	8	
1983	2	
1984	12	
1985	16	29
1986	12	26
1987	7	4
1988	5	4
1989	6	17
1990	2	10
1991	11	20
1992	0	2
1993	6	17
1994	13	31
1995	3	16
1996	1	11
1997	3	13
1998	7	26

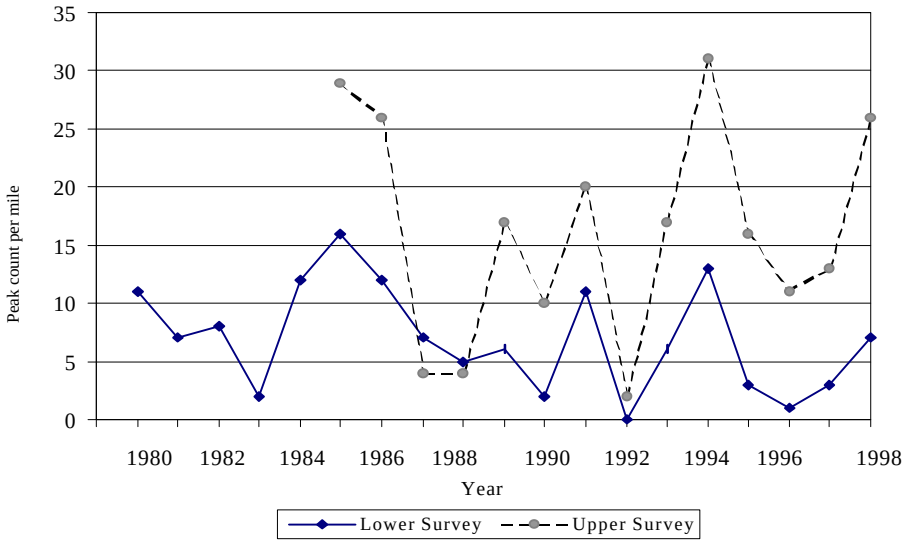

Figure 6. Devils Lake, Rock Creek adult coho spawner survey.

Net sampling of Devils Lake suggests increased abundance of both juvenile coho salmon and hatchery rainbow trout (Table 7). However, net sampling has been intermittent and at different dates

which could also effect results. Size of juvenile coho captured during gillnet samples indicates that they are able to reach large sizes in the lake (Figure 7).

Table 7. Juvenile coho salmon and rainbow trout captured in net sampling of Devils Lake.

Date	Coho	Trout
5/81		4
3/84	2	5
10/92	0	2
5/93	5	8
7/94	4	41
9/94	0	31
5/9/96	26	44
10/96	0	17
4/25/97	27	114

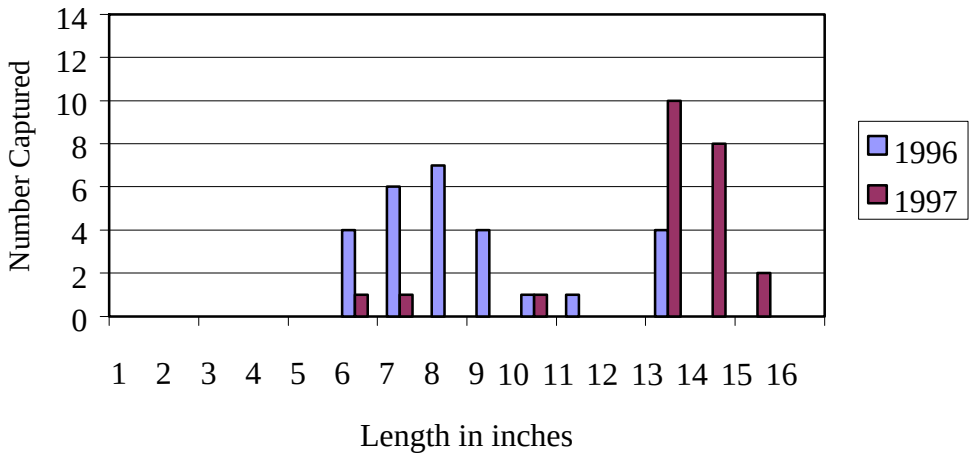

Figure 7. Devils Lake coho 1996-97 Spring gillnet samples.

Discussion

It appears that grass carp are a powerful tool capable of altering fish populations in eutrophic coastal lakes with abundant aquatic macrophytes and warmwater gamefish. In Devils Lake, following macrophyte elimination, panfish quickly declined to very low levels, while largemouth bass are declining at a slower rate due to lack of recruitment.

Warmwater gamefish are thought to be detrimental to native coho salmon through both competition for food and space and direct predation. In Devils Lake, wild coho returns have been variable since warmwater gamefish declines have been occurring. The time frame is short however at only 3 years, and occurred when other environmental factors resulted in record low coho returns to adjacent streams. Additional years of monitoring are necessary to more definitively understand effects of macrophyte and warmwater gamefish reductions on native coho salmon.

Wild coho population trends in other Oregon coastal lakes suggest potential benefits to native coho. Coho salmon returns to Tenmile Lake declined following bluegill and largemouth bass

introductions in the early 1970's and have not recovered (Figure 8). Nearby coastal lakes (Siltcoos and Takhenitch) have had a full assemblage of warmwater gamefish and stable coho returns throughout this time frame suggesting the Tenmile declines were caused by the bluegill and/or bass introductions.

Devils Lake represents an opportunity to better understand the effects of warmwater gamefish on native coho. Monitoring of fish populations must continue, or may need to be expanded for more definitive results.

Future decisions are also needed on grass carp re-stocking of Devils Lake. It is uncertain how long the existing grass carp population will hold macrophytes down. Resurgence of macrophytes will almost certainly lead to increased populations of exotic warmwater fish. Options currently available include removal of grass carp to stimulate macrophytes and warmwater fish recovery, supplemental stocking of grass carp to assure macrophytes do not come back, or let the current situation play out until attrition in the grass carp population allows macrophyte recovery. Under this third option it is very uncertain when sufficient grass carp would die out to allow recovery of aquatic plants.

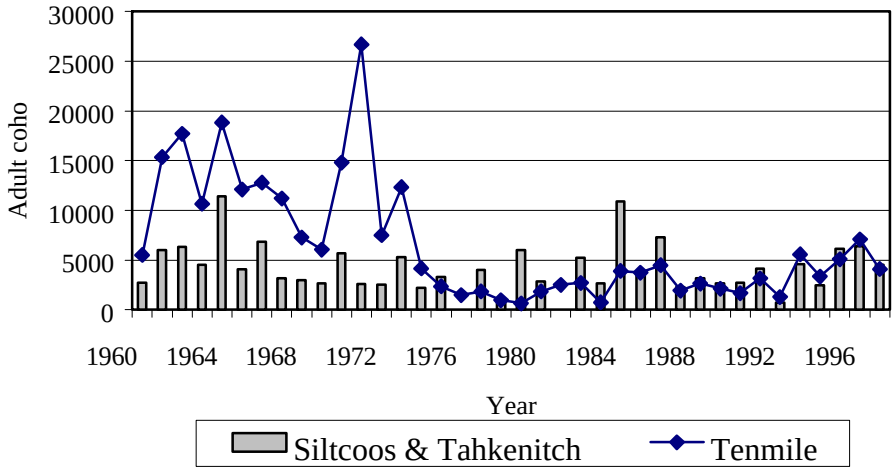

Figure 8. Adult coho spawners.

References

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Thomas, G. L., S. L. Thiesfeld, S. A. Bonar, J. D. Frodge, and G. B. Pauley. 1989. Short-term effect of triploid grass carp (*Ctenopharyngodon idella*) on the plant community, fish assemblage, and water quality of Devils lake, Oregon. Prepared for DLWID, 112 P.